1. INTRODUCTION

Stormwater management is an issue of great importance for the City of Lincoln. Several creeks converge in the vicinity of Lincoln, draining several hundred square miles of land area. One hundred floods have been recorded in Lincoln since 1900, including 17 major floods and 30 moderate floods, with the remainder being minor flood events (Nebraska Department of Natural Resources). The flash flood of August 28, 2002, as shown in the photograph to the right, is a reminder of how Lincoln is susceptible to flooding. These floods result in major inconveniences to the city, property damage, and, sometimes, loss of life.

52.nd and R Street

There are measures that can be taken to help reduce the impacts of rainfall and stormwater runoff in the City. This document introduces alternative best management practices (BMPs) that can be implemented to reduce stormwater runoff impacts. These BMPs maximize infiltration of rainfall and detention of runoff, and slow the volume and rates of water entering the system of streams draining Lincoln.

These guidelines present BMPs that can be used in small urban settings as well as larger, broad-scale developments. Please note that the information provided in this introductory guideline is provided only for explanation and illustration of key concepts. It is not the intent of this guideline document to provide in-depth "how to" guidance, as most BMPs require site-specific design details that require evaluation of hydrologic, soil, and vegetation conditions that impact stormwater flow. The first section of this guideline introduces the concepts and philosophy behind alternative BMPs, and how they can be applied throughout the City. Section 2 explains BMP site selection methods, followed by descriptions of nineteen BMPs in Section 3. Section 4 includes selected articles describing how alternative BMPs have successfully mitigated stormwater issues in other locations, while also enhancing the quality of life and value of land where they have been implemented. Section 5 contains bibliographic information for the sources referenced in this document.

1.1 Re-Defining a Philosophy

In the past, conventional wisdom for stormwater management held that water was a problem to solve rather than a valuable resource to conserve. Historically, the primary objective of conventional stormwater engineering methods has been to convey stormwater away from our developed areas, seeking to quickly export water away from where it falls instead of beneficially storing and using the resource. In nature, by contrast, stormwater is dispersed across the landscape, reducing water runoff volumes and release rates while simultaneously cleaning the water through natural filtration processes.

As native vegetation is replaced by impervious surfaces created by conventional development, these natural stormwater management and treatment functions are lost, resulting in increased runoff, flooding, erosion, and pollution. Plant species imported from other parts of the world, such as many or our turf grasses, do not provide sufficient infiltration of rainwater and, therefore create more runoff than would occur under native vegetation. With increased amounts of paved areas

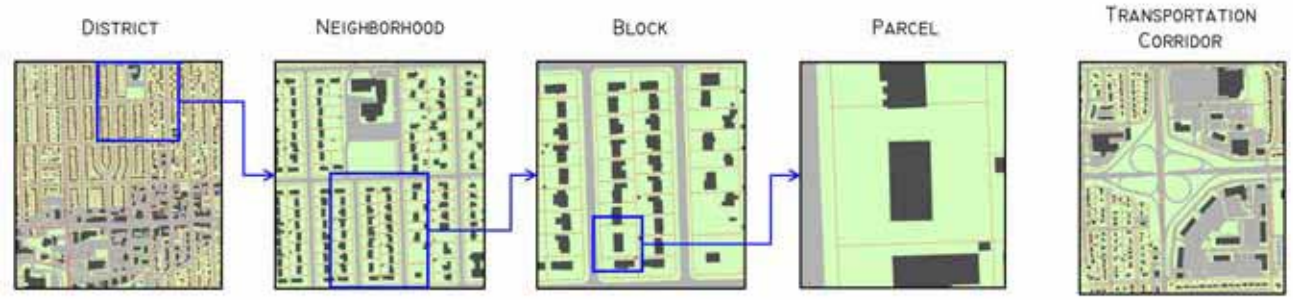
and impervious surfaces, and shallow-rooted vegetation, filtration and infiltration of stormwater that occurs when native vegetation is in place is greatly reduced, and traditional stormwater management quickly sends increased runoff rates and volumes into streams or concrete channels.

1.2 Alternative Stormwater Management

Alternative BMPs for stormwater management emulate natural systems by integrating a variety of dispersed treatments at multiple scales, from backyard rain gardens to district-level biodetention basins (Table 1). They are widely applicable in both urban and rural environments. These treatments can be designed into new developments or retrofit into existing community open spaces, parks, road rights-of-way, side and rear areas of homes and commercial buildings, rooftops of structurally adequate buildings, below parking lots and in many other settings. All aspects of alternative stormwater management can be integrated to contribute to positive community aesthetics and economics.

Table 1 – Suitability of BMP applications at multiple planning and management scales

BMP	Level					
	Parcel		Block	Neighborhood	District	Transportation Corridor
	Residential	Commercial/ Governmental				
Bioretention Area	X	X	X	X	X	X
Wet Detention (Ponds and Lakes)		X	X	X	X	X
Dry Detention Basin		X	X	X	X	X
Filter Strip	X	X	X	X	X	X
Grassed Swale	X	X	X	X	X	X
Green Roof	X	X				
Infiltration Basin		X	X	X	X	X
Infiltration Planter	X	X				
Infiltration Trench	X	X	X			X
Natural/Native Vegetation	X	X	X	X	X	X
Pervious Pavement	X	X	X	X		X
Rain Barrels & Cisterns	X	X				
Rain Garden	X	X	X	X		
Soil Management	X	X	X	X		X
Stormwater Treatment Train	X	X	X	X	X	X
Subsurface Storage		X			X	X
Urban Forest	X	X	X	X	X	X
Vegetated Bioswale	X	X	X	X	X	X
Wetland		X	X	X	X	X



Alternative BMPs, implemented early in the hydrologic cycle, can disperse stormwater and more closely replicate natural hydrology. For example, an approach called the Stormwater Treatment Train™ (STT), a series of alternative BMPs that are sized, engineered and ecologically designed for low maintenance, addresses site-specific stormwater runoff rates and required water quality improvements. The STT is basically a landscape-scale design that slowly moves water through natural features to infiltrate, evaporate, filter and clean stormwater. Flows are not piped or concentrated, but are dispersed and diffused by allowing runoff to slowly move through vegetated swales and prairie plantings rather than pipes. Stormwater can then more effectively re-enter the cycle of soil infiltration, vegetation uptake, evaporation and storage in gardens, landscaping, wetlands and ponds.

1.3 BMP Applications

Alternative BMPs include a variety of methods that are simple and practical in design, yet provide effective stormwater management as well as aesthetic enhancements for urban, suburban, and rural landscapes. These methods can be cost effective to build while providing long-term sustainability for City infrastructure and conservation of Lincoln's water resources. These guidelines presents information on the following alternative BMP types:

- Bioretention Area
- Wet Detention (Ponds and Lakes)
- Dry-Detention Basin
- Filter Strip
- Grassed Swale
- Green Roof
- Infiltration Basin
- Infiltration Planter
- Infiltration Trench
- Natural/Native Vegetation
- Pervious Pavement
- Rain Barrels and Cisterns
- Rain Garden
- Soil Management
- Stormwater Treatment Train
- Subsurface Storage
- Urban Forest
- Vegetated Bioswale
- Wetland

1.4 Examples of BMP Applications

In relatively small areas, alternative BMPs can effectively reduce stormwater runoff volume and velocity, slowing down and reducing stormwater runoff, allowing infiltration, soil storage, and available water for vegetative uptake. The following descriptions show how BMPs can be used in a variety of applications, from small-scale BMPs located within individual parcels to large-scale BMPs potentially spanning a large number of parcels and zoning classes.

1.4.1 Parcel-Level Applications

A variety of BMP types are well suited to implementation in residential parcels (i.e. on the scale of a single homeowner). BMPs at this scale are relatively inexpensive and easy to install and maintain. Taking advantage of these dispersed watershed management opportunities can greatly reduce the need for expensive, large scale infrastructure construction, expansion, and maintenance. Implementation of BMPs within residential parcels not only facilitates stormwater management for a watershed, it also involves citizens in the management process. The installation of rain gardens, vegetated swales, and various other small-scale BMPs provides homeowners with opportunities to mitigate stormwater runoff from their property while also adding

to the aesthetic value of their homes (Figure 1). Alternative BMPs typically can be retro-fitted into existing landscaping or integrated into new landscaping layouts.

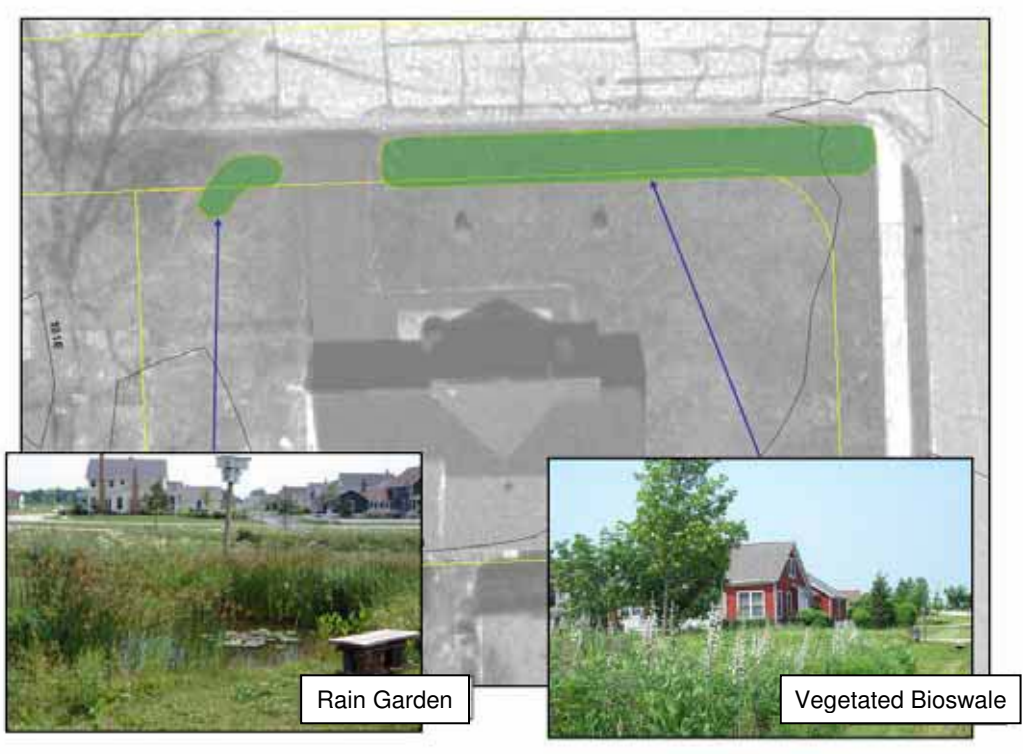


Figure 1: BMP applications at the residential level

Commercial properties by their nature feature extensive areas of impervious surfaces, resulting in large volumes of stormwater runoff. The increased runoff caused by these extensive impervious surfaces can overwhelm the City's stormwater systems and drainageways and rapidly erode and degrade streams. Parking lots are the primary features responsible for creating these increased runoff rates and volumes. They also impair water quality, since water flowing across their surfaces is more likely to pick up sediments and pollutants present there. Though large parking lots are sometimes required to accommodate customers, a variety of BMP types can mitigate these impacts (Figures 2 and 3).

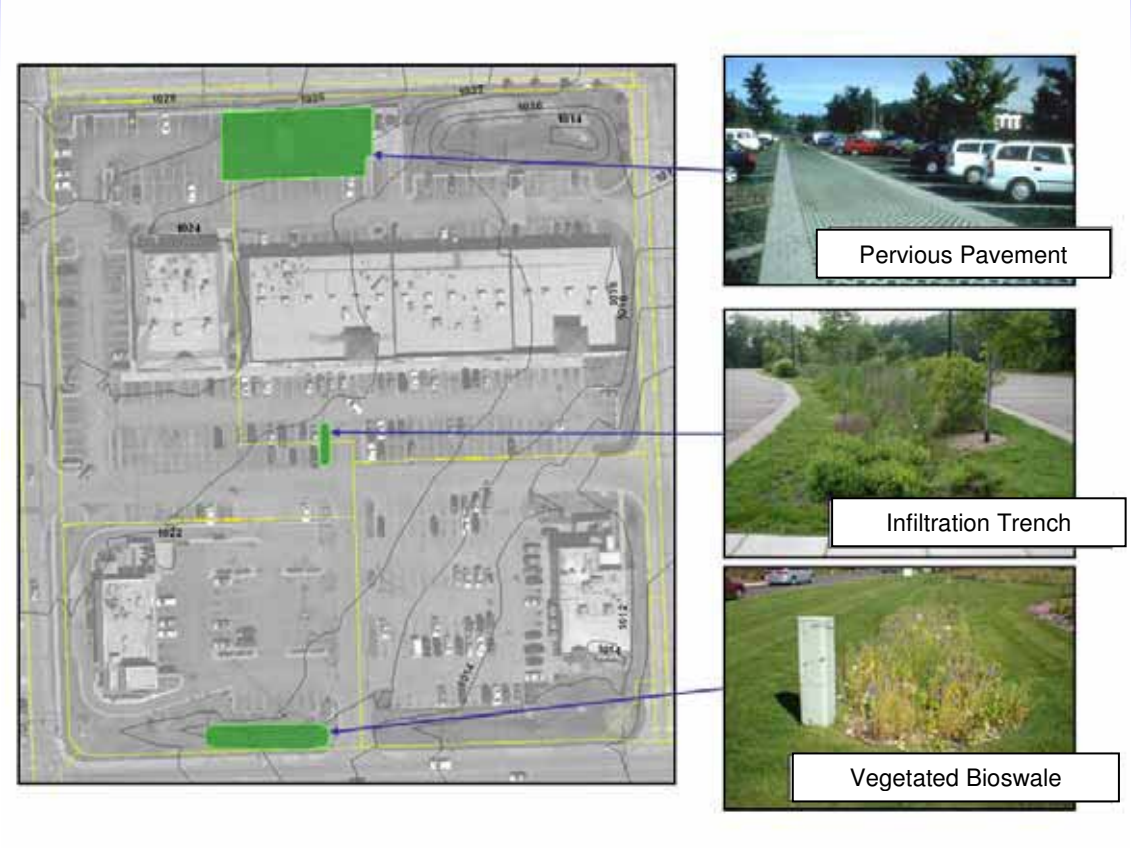


Figure 2: Examples of potential BMP applications in a commercial parking lot

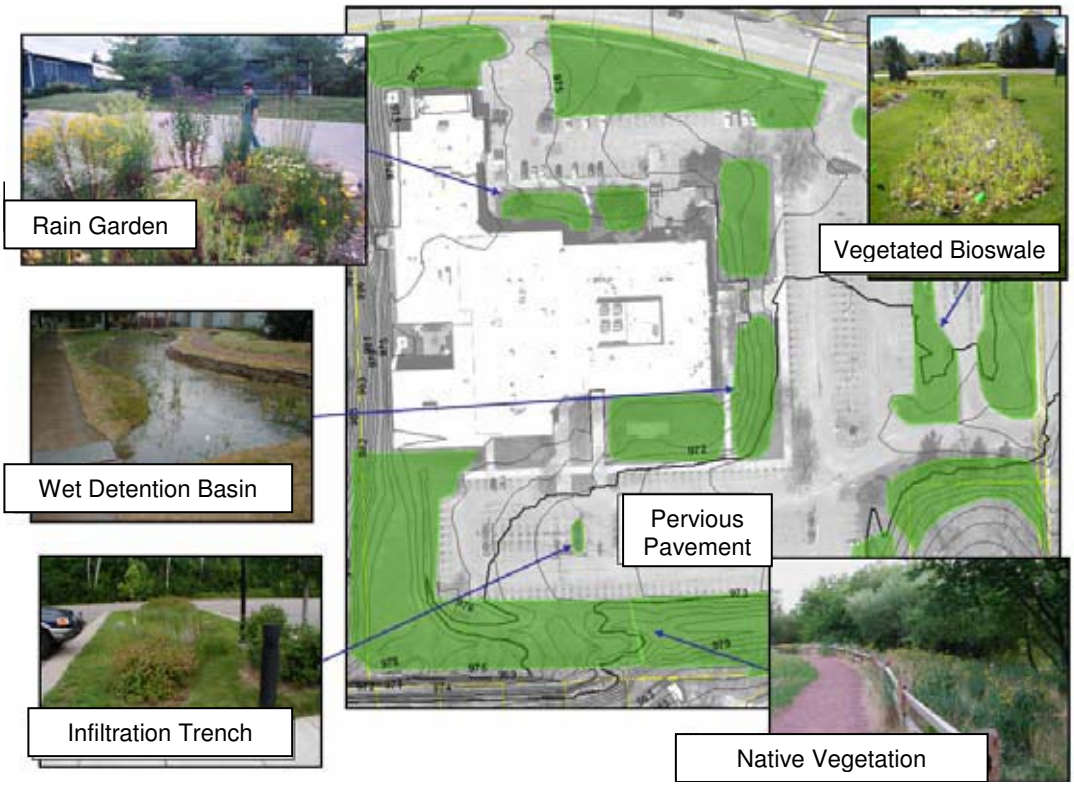


Figure 3: More examples of potential BMP applications in a commercial parking lot.

1.4.2 Block and Neighborhood-Level Applications

At the block- and neighborhood levels, BMPs can be coordinated between landowners and installed across several properties to optimize their impact for controlling stormwater runoff. Neighborhoods may consider installation of rear-yard and road right-of-way interconnected rain gardens and bioswales, pocket parks, and restored wetlands and prairie patches. At the block- and neighborhood-level, BMPs take advantage of open spaces overlapping numerous residential parcels. Sometimes, these open spaces occur in areas held as utility or rights-of-way easements, and they may simply represent management issues for homeowners who must maintain them, but are not able to place improvements on them.

Figure 4: Applications of BMPs at the Block or Neighborhood Level

1.4.3 District-Level Applications

The implementation of bioretention areas, bio-detention basins, infiltration basins, corridor and pocket parks, stream, prairie and wetlands restoration BMPs can be completed for more wide-scale stormwater management.

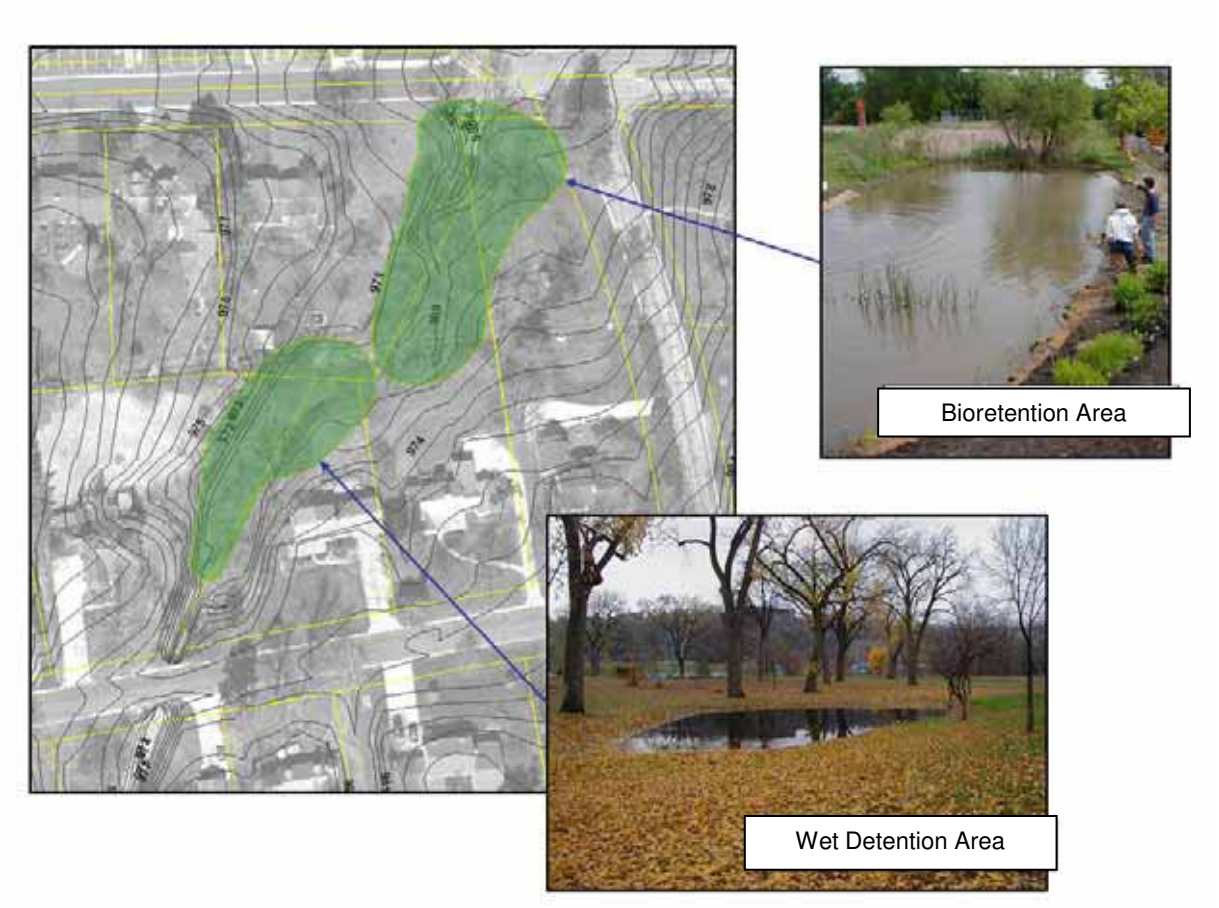


Figure 5: District-level implementations include large-scale BMPs such as bioretention areas and wet detention areas.

1.4.4 Transportation Corridor Applications

Transportation corridors often contain relatively large, open spaces requiring regular maintenance, such as mowing, herbiciding, and erosion control. These areas may be among the only open spaces remaining once an area is fully developed, and offer important opportunities for the implementation of various BMP types. BMPs such as bioretention areas, detention basins, infiltration basins, and prairie and wetland restoration can be implemented within cloverleaf interchanges, while corridor parks, filter strips, infiltration trenches, and vegetated bioswales fit well within road medians and rights-of-way. The selection of appropriate BMPs can be determined by the amount and type of space available, as well as the topography of the transportation features.

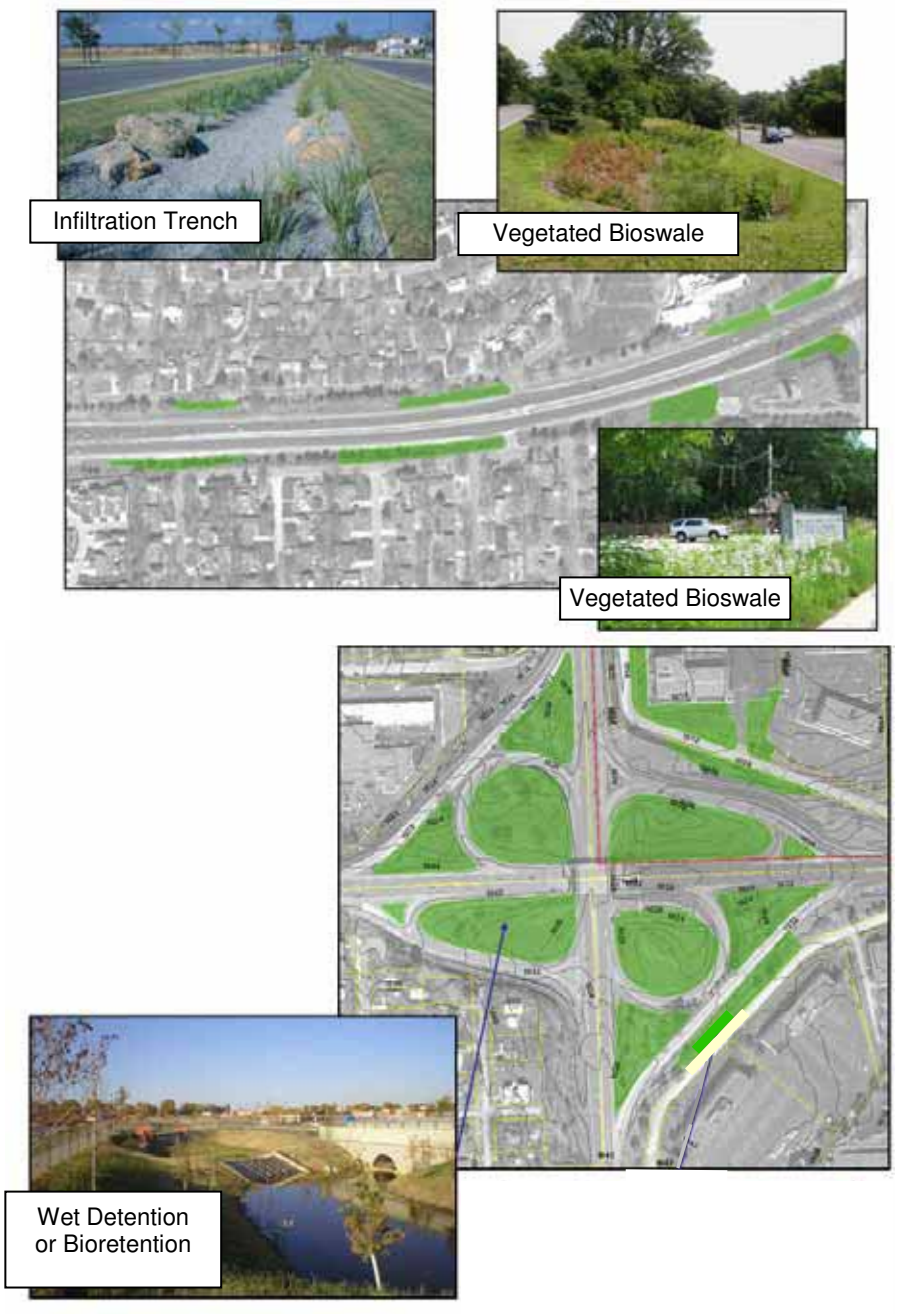


Figure 7: Examples of how BMPs can be implemented with transportation corridors